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(56) Documents Cited
EP 0638872 A1 EP 0442390 A1 WO 89/07295 A1

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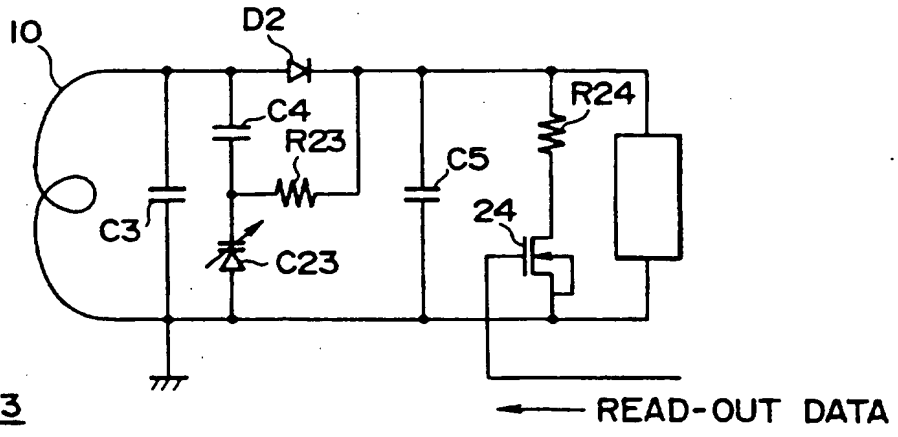
On-Line - WPI

(54) Transponder device with overvoltage protection

(57) A transponder-based ticket 23, for automatic travel ticket 'clipping', includes control circuitry for preventing damage to its components when placed too near to a transmitting, interrogating/writing device (2, fig.5). Included in the control circuitry is a variable capacitor C23, which is fed a rectified version of the voltage appearing on loop antenna 10 via resistor R23. Capacitor C23 is normally set so that the resonant circuit is tuned to the transmitting frequency of the interrogator. However, if the voltage received is too large, the capacitance of C23 is adjusted, via the feedback signal from R23, so that the resonant circuit oscillates at a frequency offset from the interrogator's transmitting frequency, thus reducing the amplitude of the received signal. When transmitting data from the transponder, FET 24 switches resistance R24 in and out of the resonant circuit, thereby enabling two different resonant frequencies to be used for transmission.

FIG. 1



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

FIG. 1

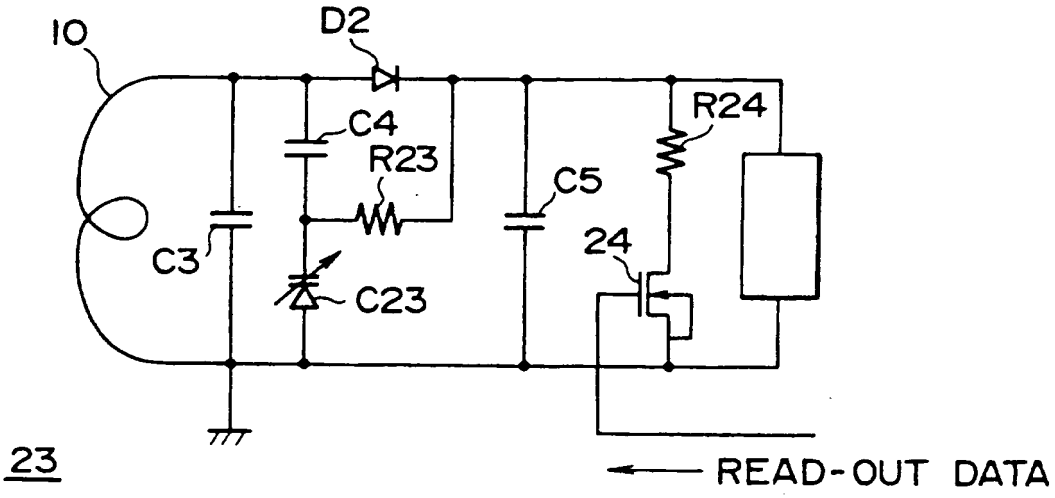


FIG. 2

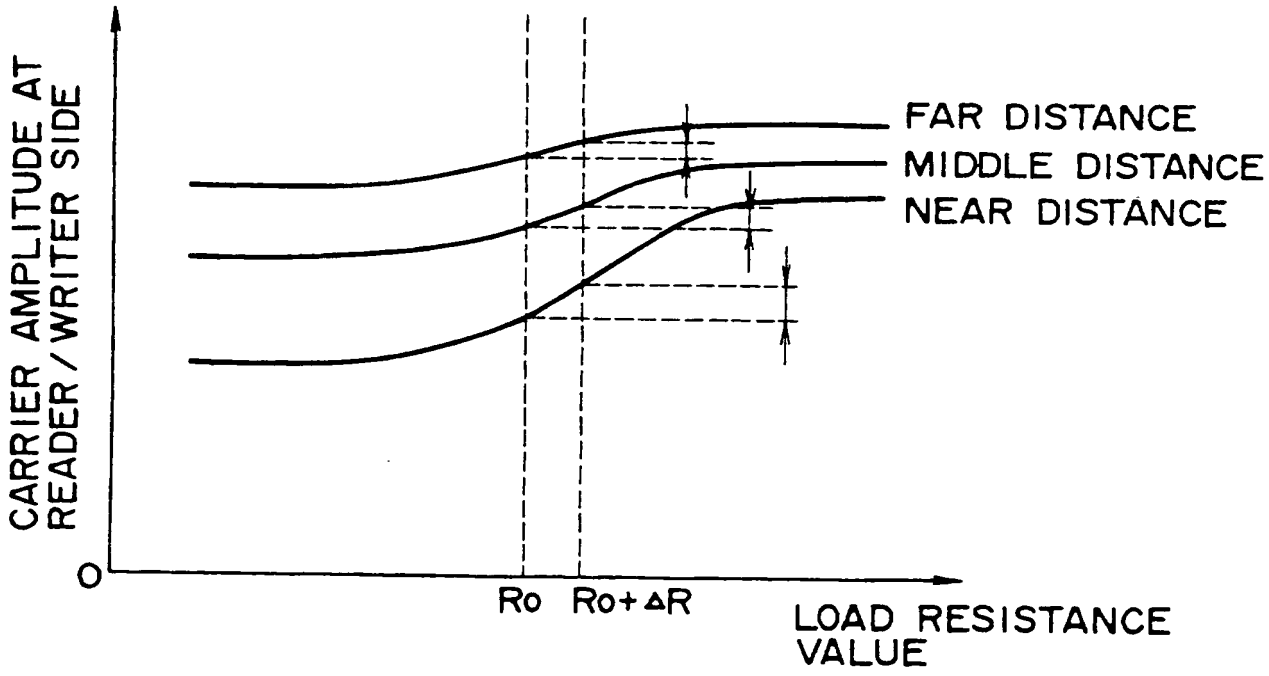


FIG. 3A

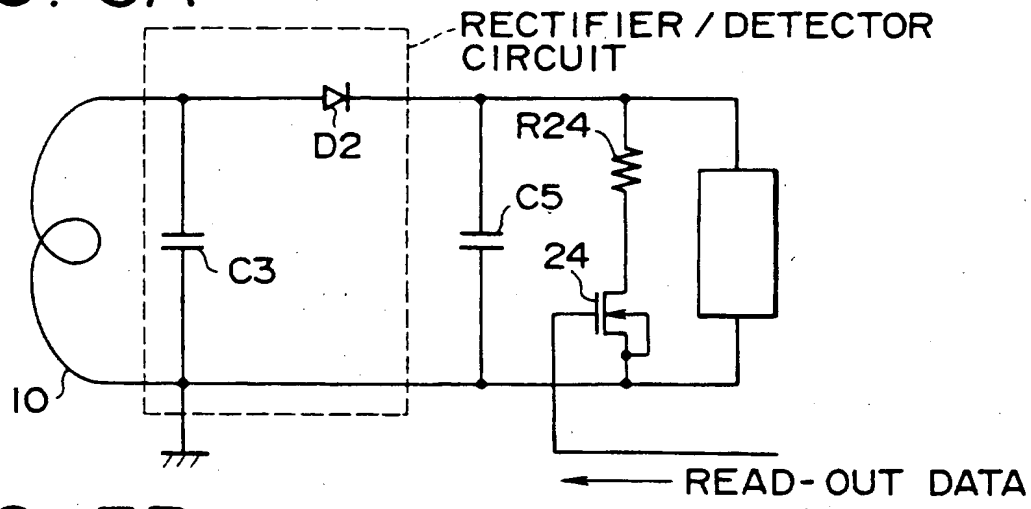


FIG. 3B

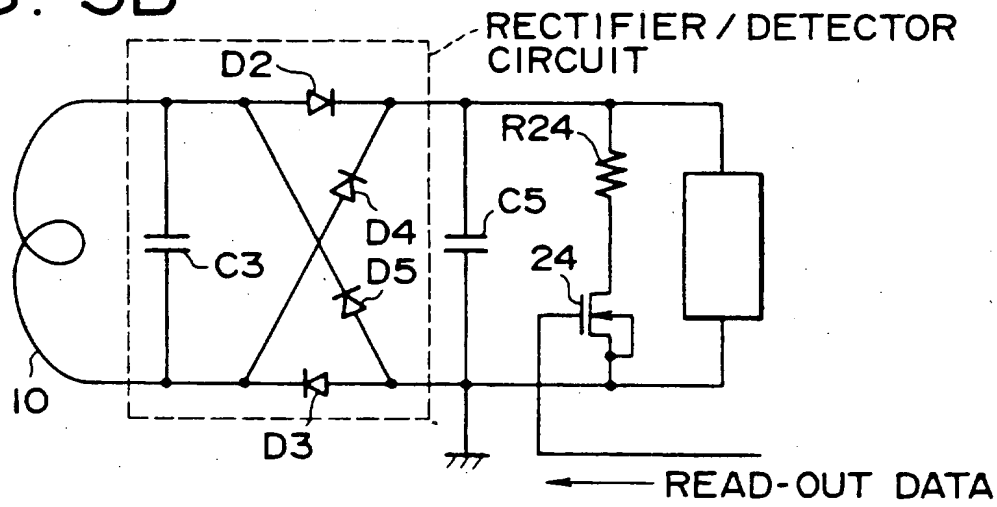


FIG. 3C

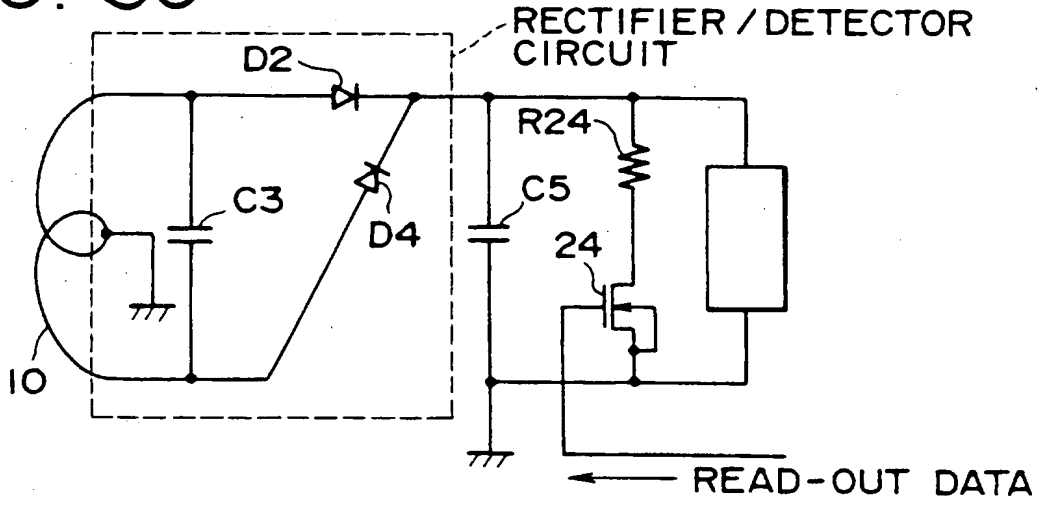


FIG. 4

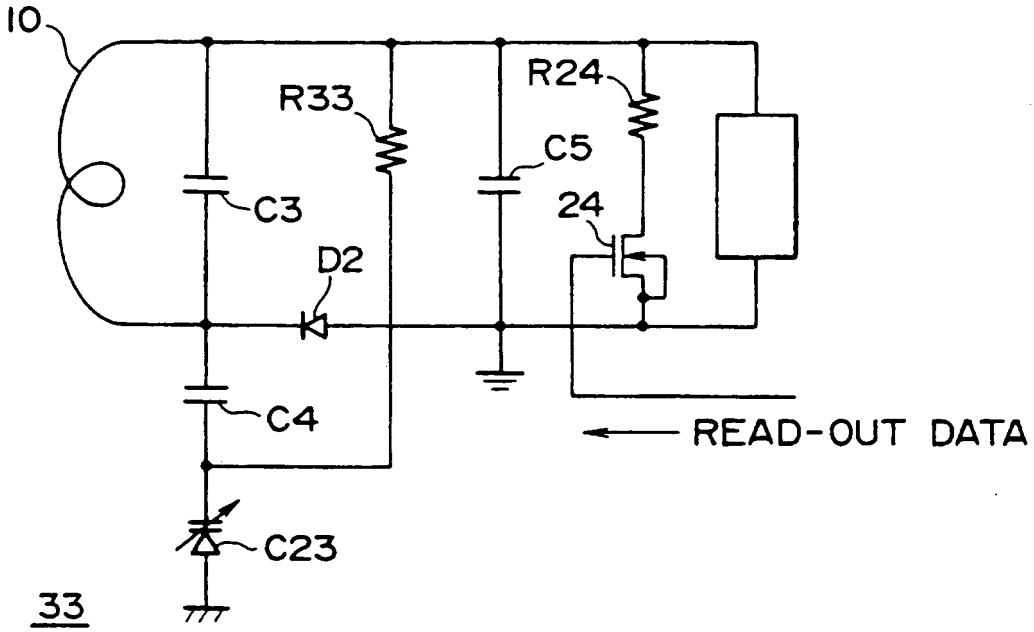


FIG. 7

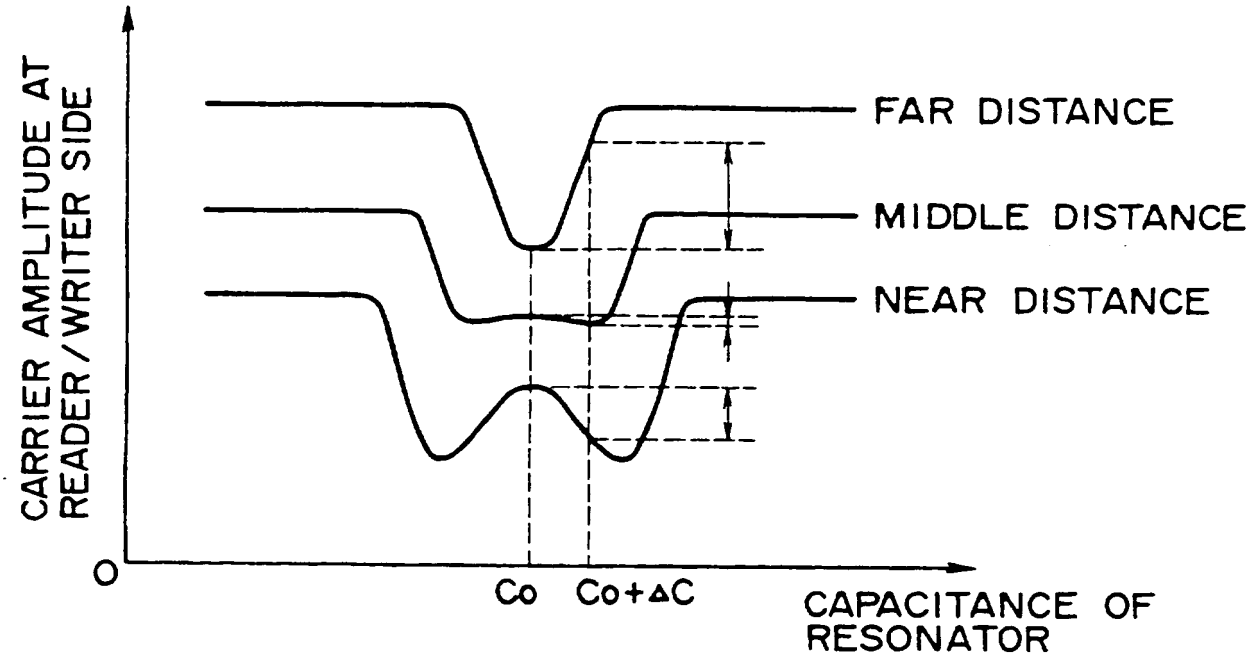


FIG. 5

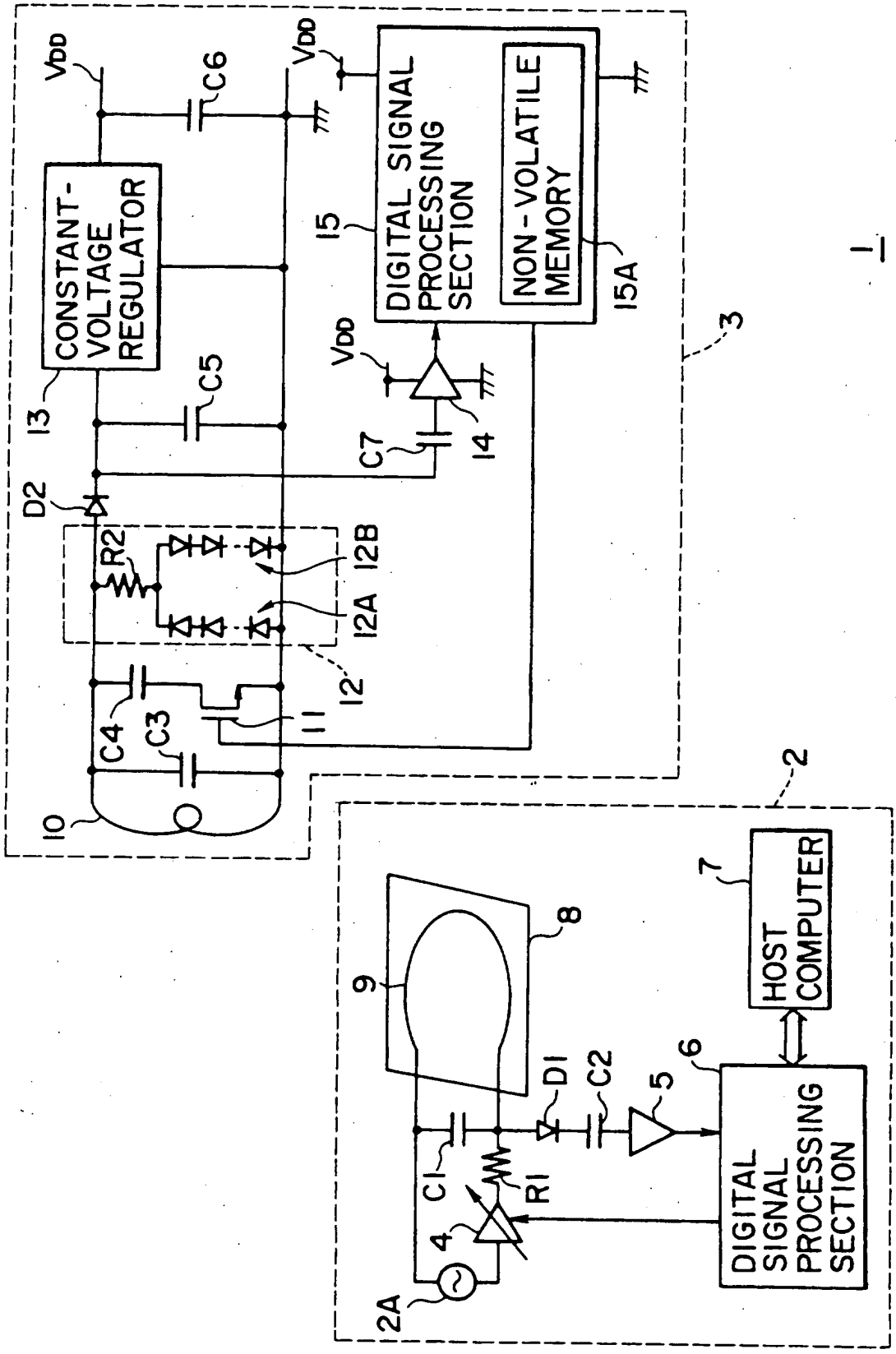
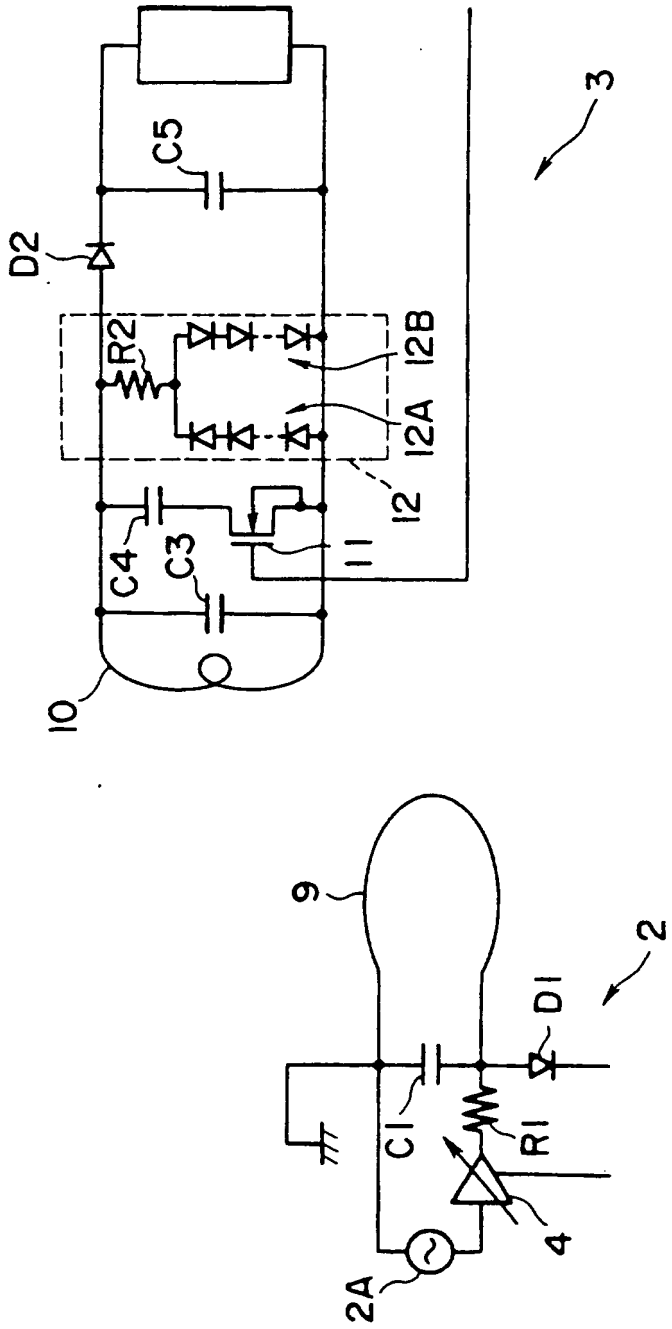


FIG. 6



NON-CONTACT TYPE INFORMATION CARD

This invention relates to an information card used in a non-contact type card system such as an automatic ticket clipping system or the like.

In the automatic ticket clipping system utilised at present, there has been employed a method for reading out information from the ticket using a magnetic head which is contacted with the ticket on insertion thereof into an automatic ticket clipping machine by a user. Due to this fact, the is put to the trouble of having to bring out the commuter ticket from his or her case, bag or the like every time the user needs to use the ticket, and to insert it into the automatic ticket clipping machine.

In view of this fact, the applicants have already proposed a non-contact type card system which does not require such troublesome procedures and which is convenient in use.

According to this non-contact type card system, since information can be given or received in a non-contact manner (data communication or the like), it becomes possible that a user can pass through an automatic ticket clipping machine while in a state in which the commuter ticket is still stored in the case, etc., which improves convenience.

Figure 5 of the accompanying drawings illustrates such a non-contact type card system. In this case, the non-contact type card system is constructed by the reader/writer 2 corresponding to the aforesaid automatic ticket clipping machine and an information card 3 corresponding to the aforesaid commuter ticket, wherein electrical power is supplied via the medium of an applied electromagnetic wave and concurrently data is read or written.

Firstly, referring to Figure 6, an internal operation in the case where information is read out of the information card 3 by the reader/writer 2 will be described. However, Figure 6 is a circuit diagram in which only a circuit concerning the reading-out of information of the information card 3 and a circuit concerning an overvoltage for restricting an overvoltage generated in the information card is extracted and shown.

At first, the reader/writer 2 at the reading-out side generates a desired carrier signal with a carrier generator 2A, the signal is amplified by a voltage control type amplifier 4, thereafter the signal is radiated as a magnetic field through a loop antenna 9.

At this time, when the information card 3 is placed within a range in which an electromagnetic induction signal may be sufficiently induced with the loop antenna 9, electrical power comes to be supplied from the reader/writer 2 to the information card 3. Then, it is naturally found that and electrical current flows in the loop antenna 9 and an output resistor R1 of the voltage control type amplifier 4, and so the carrier output level is decreased due to a voltage drop corresponding to the output resistor R1.

A degree of drop of this output level is changed in response to a resonance state of the resonance circuit formed by the loop antenna 9 and the capacitors C3, C4 at the information card 3.

Accordingly, when a FET11 is turned on/off in response to the read-out information at the information card 3 so as to change the resonance state, a carrier level for driving the loop antenna 9 within the reader/writer 2 is changed in response to the read-out information of the information card 3.

When the variation in this carrier level is detected by an envelope detecting diode D1, is becomes possible to read out data.

In the case where the information card 3 gets very close to the loop antenna 9, quite large-sized carrier amplitudes may be produced at both ends of the loop antenna 9 which might damage its internal circuitry, so that there is provided an overvoltage protection circuit for protecting the inner circuit against such an overvoltage as above. The overvoltage protection circuit is configured such that when amplitude levels generated at both ends of the loop antenna 9 exceed the accumulated voltage of the groups 12A, 12B of diodes, a quite high current flows in the diode groups 12A and 12B to restrict an increase in voltage.

However, the non-contact type card system proposed in the early application had the following problems.

Firstly, in the reading-out process in the aforesaid non-contact type card system, there occurred a problem of "blind spots", i.e. areas where data cannot be read out irrespective of the fact that the information card 3 and the reader/writer 2 are placed at such a distance as one in which a relative induction may be produced from each other between the loop antenna 9 and 10.

The reason for this is shown in Figure 7. This diagram indicates how carrier amplitude levels generated at both ends of the loop antenna 9 on the side of reader/writer 2 are changed in the case where a capacitance of a parallel resonance circuit at the information card 3 (the loop antenna 10 and the capacitor C3) is changed for each of the distances between the information card 3 and the reader/writer 2, respectively. According to this diagram, it shows that no change occurs at the carrier amplitude levels appearing at both ends of the loop antenna 9 even if a resonance

capacitance is changed at a middle distance region. Accordingly, it is not possible to read out data from the information card 3 at the middle distance region.

A second problem is that the occurrence of these blind spots of data reading-out are quite sensitive to the displacement of tuning frequency of a parallel resonance circuit (the loop antenna 10 and the capacitor C3) arranged on the information card 3 and in the case where a tuning displacement occurs; the position and range of the data reading-out blind spot are remarkably disturbed, so that this system is not suitable for a mass production.

In addition, a third problem consists in the fact that both a positive overvoltage protection and a long-distance data receiving operation are quite difficult to attain in the case of the overvoltage protection circuit system applied in the aforesaid non-contact type card system 1. That is, it was difficult to accommodate for such a system capable of performing a wide range communication ranging from a close-contact position to a quite far away position.

The reason for this is as follows. In the case where a communication can be performed up to quite a way away, it is necessary to radiate a quite strong magnetic field from the reader/writer 2. However, when the position is near the card, the electrical power received by the information card 3 then becomes quite high in response to it, resulting in that the overvoltage protection part must be enforced. In practice, if a value of the resistor element R2 is reduced and a current flowing into the overvoltage protection circuit is made quite high, and thereby the overvoltage is restricted; the reduction in the value at the resistor element R2 may also lead to a remarkable restriction of amplitude variation of voltage received at the loop

antenna 10. However, this data transfer system is carried out under an amplitude modulation, so it is natural that a loss of the amplitude modulation does not enable the received data to be demodulated.

The present invention has been devised in view of the foregoing, and provides an information card in which data can be communicated in an interactive mode while the information card is being positively protected against the overvoltage in all the regions ranging from the reading-out device from the far distance where an electrical power can be slightly supplied to the information card from the reading-out device to a quite near distance.

According to the present invention there is provided a non-contact type information card comprising:

means for generating a voltage in response to a variation in a magnetic field;

a resonator circuit for passing a component of said voltage in a specified frequency band;

means for rectifying an output of said resonator circuit; and

a protection circuit for applying an output voltage to said rectifier means and restricting a voltage generated by controlling said resonance circuit so as to change a resonance frequency thereof in the case where said output voltage becomes excessively large.

Since the resonance frequency of the resonance circuit is controlled in response to a receiving state of an electromagnetic wave from the reading-out device received by the resonance circuit, if the receiving state is too excessive, the resonance frequency is displaced to cause a receiving sensitivity of the device to be reduced. With such an arrangement as above, it is possible to provide a non-contact type information card in which an excessive voltage

is prevented from being produced at the output of the resonance circuit and if the voltage is within a range to produce an electromagnetic induction with the reading-out device, an overvoltage application can be avoided with no sacrifice in a writing characteristic.

In addition the load state of the resonance circuit is electrically controlled by a control means arranged between an output of a rectifier means and the ground in response to the reading-out data, and thereby it is possible to provide a non-contact type information card in which information can be read out without being dependent on a positional relation if it is within a range to produce an electromagnetic induction with the reading-out device.

The invention will be further described by way of non-limitative example with reference to the accompanying drawings, in which:-

Figure 1 is a connecting diagram showing an example of the configuration of the information card of the present invention;

Figure 2 is a graph showing a relationship between a load resistance and a drive voltage in a loop antenna at the reader/writer in a resonance circuit of a non-contact type information card;

Figure 3 is a circuit diagram showing an example of application in the case where the rectifier circuits of various circuit configurations are combined with the information card of the present invention;

Figure 4 is a connecting diagram showing an example of the configuration of the information card of the present invention;

Figure 5 is a block diagram showing a general configuration of the non-contact type card system;

Figure 6 is a schematic connecting diagram showing only a circuit part related to the reading-out information stored in the information card and a circuit part related to an overvoltage protection for restricting an overvoltage generated in the information card in the non-contact type card system; and

Figure 7 is a graph showing a relation between a capacitance of a resonator capacitor in a resonator circuit and a drive voltage at a loop antenna of the reader /writer side of the non-contact type card system.

In the drawings,

1 is a non-contact type card system

2 is a card reader/writer

3,23,33 are information cards

8 is a printed circuit board

9,10 are loop antennae.

(1) First Preferred Embodiment

In Figure 1 in which the corresponding parts in Figure 5 are denoted by the same reference numerals is shown an example of circuit configuration of the front end part of the information card 23 of the present invention.

In the case of the information card 23 shown in Figure 1, it differs from that of Figure 5 in that the parallel resonance circuit is constituted by a loop antenna 10, capacitors C3, C4 and a variable capacitor C23. In addition, one end of the parallel resonance circuit is connected to the ground and the other end is connected to

an anode of the diode D2.

A pure resistor element R23 is connected between a cathode side of the diode D2 and the variable voltage capacitor element C23 and a voltage rectified by the diode D2 is applied to the variable capacitance element C23 as a control voltage.

In addition, the cathode side of the diode D2 is set such that the pure resistor element R24 is connected to the ground through a drain/source of a FET24 and this FET24 is on/off controlled in response to the read-out data to enable a load resistance value of the parallel resonance circuit to be variable and then a resonance frequency is changed.

With such a foregoing arrangement described above, a method for reading out information of the information card 23 with the reader/writer 2 (that is, a reading method) and an overvoltage protection method for restricting an overvoltage generated in the information card 23 when the information card 23 approaches very near the reader/writer 2 will be described.

At first, an operating principle of the information card 23 having the above construction will be described in

reference to the case in which information is read out from the reader/writer 2.

The reader/writer 2 amplifies a desired frequency carrier generated at the carrier generator 2A to a desired level by a voltage-controlled type amplifier 4 and radiates it as a magnetic field through the loop antenna 9. In this case, when the information card 23 is sufficiently positioned in a range to induce an electromagnetic induction with the loop antenna 9, electrical power is supplied from the reader/writer 2 to the information card 23.

Then, naturally, a current flows in the loop antenna 9 and the output resistor R1 of the voltage-controlled type amplifier 4 and a carrier output level is decreased due to a voltage drop corresponding to an output resistor R1. A degree of drop in the output level is determined by a value of load resistance between the cathode of the diode D2 at the information card 23 and the ground. Accordingly, if the value of the load resistance between the cathode of the diode D2 and the ground is changed by turning on/off the FET24 in reference to the read-out information of the information card 23, a carrier level for driving the loop

antenna 9 in the reader/writer 2 is changed in reference to the read-out information of the information card 23. The data reading-out operation is carried out by detecting this carrier level variation with the diode D1 for detecting an envelope.

However, in the case where the value of the load resistance is changed, it becomes apparent that a variation in the carrier amplitude of the reader/writer 2 does not depend upon a resonance state of the loop antenna 10 and the capacitor C3 as shown in Fig. 2. Accordingly, as long as the information card 23 is placed in a distance range where an electromagnetic induction is produced with the loop antenna 9 at the side of the reader/writer 2, it becomes possible to read out data in all regions.

During mass production, less influence is applied to the reading-out characteristic even if a tuning frequency is slightly displaced and further a dispersion in mass production is also restricted. In addition, the information reading-out system for the information card 23 provided in the present invention shows quite good adaptation for any type of rectifying circuit and thus it can be operated under any type of restricting conditions

produced when the card is formed in IC.

Fig. 3 shows an example of application of various types of the rectifier/detector circuit.

Next, the operating principle of the overvoltage protection circuit of the information card 23 will be described. The operating principle of the present system consists in the fact that in the case where the information card 23 approaches quite near the loop antenna 9 of the reader/writer 2, a resonance frequency is displaced in response to a receiving level at the information card 23 to reduce a receiving efficiency and then an overvoltage is protected. The present information card 23 is operated such that a voltage rectified after receiving through the pure resistor element R23 is applied to the variable capacitor element C23 and then the capacitance is changed in response to the receiving level. With such an operation as above, it becomes possible that the frequency is displaced and the receiving efficiency is reduced.

Practical operation is performed as follows. In the case where the information card 23 approaches quite near the loop antenna 9 of the reader/writer 2, it is

natural that an electrical power energy received at the loop antenna 10 in the information card 23 is also increased. This received voltage is applied to the variable capacitance element C23 through the pure resistor element R23, so that resonance is displaced under the received voltage.

The fact that the displacement of the resonance frequency naturally results in a reduction of receiving efficiency.

Accordingly, a voltage received at the loop antenna 10 in the information card 23 is restricted and an overvoltage protection is accomplished. According to this overvoltage protection method, since the amplitude variation component received at the loop antenna 10 is not restricted, information of read-out data modulated in amplitude is not lost at the information card 23 and then a positive overvoltage protection becomes possible.

Naturally, the present system can be used together with another overvoltage protection circuit.

According to the aforesaid configuration, it is possible to provide a non-contact type information card in which as a capacitance element constituting the parallel

resonance circuit, the variable capacitance element C23 having its capacitance variable in response to an applied voltage is used and a voltage after rectifying upon receiving is applied to the variable capacitance element C23, and thereby even though the received voltage becomes excessive, a capacitance of the variable capacitance element C23 is changed in reference to the voltage to reduce a receiving efficiency and the received voltage does become excessive. Accordingly, it is possible to obtain the information card capable of reading out or writing data stably within any regions while the overvoltage protection is being carried out in a range where it can induce an electromagnetic induction between the reader/writer 2 and the same.

(2) Second Preferred Embodiment

In Fig. 4 in which the same reference numbers are applied to the corresponding parts in Fig. 1 is illustrated a second preferred embodiment of the information card of the present invention.

A difference between this information card 33 and the information card 23 illustrated in the first preferred embodiment consists in the fact that the connecting method for the rectifier circuit and the variable capacitance

element is different and other portions have quite the same configuration as that of the information card 23.

In this case, when a connecting path of the variable capacitance element is applied in an AC manner, the smoothing capacitor C5 is sufficiently high and a connecting point between the loop antenna 10 and the resistor element R33 is kept at a ground level, so that it is equivalent to the case in which it is connected in parallel with the capacitor C4, the variable capacitance element C23 and the capacitor C3. Accordingly, the information card 33 operates in a quite same manner as that of the information card 23 shown in the first preferred embodiment. Accordingly, also in this case, it is possible to change the resonance frequency in response to a variation in capacitance of the variable capacitance element.

In addition, since a ground-connected diode is used as a rectifier/detector diode in this preferred embodiment, this card is quite preferable for an IC formation receiving various restrictions in circuit.

According to the aforesaid configuration, it is possible to obtain a non-contact type information card in

which the variable capacitance element C23 of which capacitance is changed in response to an applied voltage is used as a capacitor element constituting a parallel resonance circuit, and a voltage after rectifying upon receiving is applied to the variable capacitance element C23, so that even if the received voltage becomes excessive, the capacitance of the variable capacitance element C23 is changed in response to the voltage and a receiving efficiency is decreased and the received voltage can be prevented from becoming excessive amount. Accordingly, it is possible to obtain an information card in which data can be read out or written stably in any regions while an overvoltage protection is being positively carried out within a range in which the information card generates an electromagnetic induction between the reader/writer 2 and the same.

(3) Other Preferred Embodiments

In the aforesaid preferred embodiments, the example of the information card which is constructed as shown in Figs. 1, 3 and 4 has been described. The present invention is not limited to this example and can be applied to another example of connection other than the above. Although the case in which the resonance frequency is

controlled by changing a capacitance of the variable capacitance element has been described, it can be controlled with other means.

As described above, according to the present invention, a resonance frequency of the resonance circuit passing a voltage component in a desired frequency band of voltages generated in response to a variation in a magnetic field is controlled in reference to an output voltage of a rectifier means for rectifying an output of the resonance circuit. Accordingly, even in the case where a large voltage is generated in the information card due to the fact a receiving state of an electromagnetic wave from a reading-out device side received by the resonance circuit is excessive, resulting in that the resonance frequency can be displaced with the voltage and the receiving sensitivity can be reduced. Accordingly, it is possible to provide a non-contact type information card capable of preventing an overvoltage from being applied with no sacrifice in the writing characteristic in a range in which the information card generates an electromagnetic induction between the reading-out device and the same.

In addition, it is possible to provide a non-contact type information card in which a loaded state of a resonator circuit is controlled electrically in response to the read-out data by the control means arranged between the output of the rectifier means and the ground, and thereby information can be positively read out without being dependent upon a positional relation in a range in which the information card generates an electromagnetic induction between the reading-out device and the same.

CLAIMS

1. A non-contact type information card comprising:

means for generating a voltage in response to a variation in a magnetic field;

a resonator circuit for passing a component of said voltage in a specified frequency band;

means for rectifying an output of said resonator circuit; and

a protection circuit for applying an output voltage to said rectifier means and restricting a voltage generated by controlling said resonance circuit so as to change a resonance frequency thereof in the case where said output voltage becomes excessively large.

2. A non-contact type information card according to claim 1, wherein said resonance circuit is composed of a parallel connection of a coil, a first capacitor and a voltage-controlled type variable capacitance capacitor; and

said protection circuit is operative to apply an output voltage of said rectifier means to said variable capacitance capacitor and variably controls a resonance frequency of said resonance circuit by varying its capacitance in response to said output voltage.

3. A non-contact type information card according to claim 1 or 2, wherein control means capable of controlling electrically a state of resistive load in said resonance circuit in response to the read-out data is arranged between an output of said rectifier means and the ground.

4. A non-contact type information card according to claim 3, wherein said control means is composed of a

resistive element and a transistor element and electrically controls a loaded state by turning on or off said transistor element.

5. A non-contact type information card constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in Figures 1 to 4 of the accompanying drawings

The Patent Office

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Application No:	GB 9624042.9	**Examiner:**	Mr Jared Stokes
Claims searched:	1 to 5	**Date of search:**	23 January 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H4L (LADMX, LADTX, LADCS, LECP)

Int Cl (Ed.6): G01S (13/02, 13/76)
G06K (7/08, 7/10, 19/07, 19/77)
G07B (15/00, 15/02)
G07C (9/00)

Other: On-Line - WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	EP 0 638 872 A1	(N.V.) See abstract	-
X	EP 0 442 390 A1	(Texas) See column 1 line 42-column 2 line 38 and figure	1
A	WO89/07295 A1	(Magellan) See column 5 lines 15-19	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.